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COVER: Unpalatable saltgrass may be replaced by desirable forage species, recovering valuable range for livestock grazing (0974X1539–13). Article begins on page 3.

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John A. Knebel, Interim Secretary
U. S. Department of Agriculture

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Just a Dash of Capsaicin, Please

The human race has grown strong and tall—or, if you like, soft and fat—while being exposed to countless chemicals for countless centuries.

We are immersed in a world of chemicals—the air above us, the ground beneath us, and the oceans around us are seething masses of chemical reactions.

In the right amounts, most chemicals are harmless and actually essential for human health, since we, too, are masses of chemical reactions.

Most children quickly learn that while a little bit of something can be very good, a whole lot might be a disaster. Not everyone learns this—some people have a lifelong struggle with hot fudge sundaes, alcohol, hot peppers, or garlic.

Large dietary quantities of copper, tin, sodium, zinc, and iron will poison you. Each element, however, in small amounts is necessary and even essential for human health. Even too much table salt (sodium chloride) or water (aqueous solution) can kill you.

The freshest fruits and vegetables are crammed with an astonishing array of chemicals such as hydrocarbons, ketones, esters, lactones, acids, alcohols, and mercaptans.

The luscious orange that goes into your breakfast juice is composed primarily of sugar (sucrose, glucose, and fructose), citric acid, and ascorbic acid. What makes the orange taste like an orange, however, is the peel oil, which is a combination of 200 to 250 different chemicals. Orange peel oil is so complex that chemists have not yet been able to duplicate it.

Complex chemical reactions are taking place even inside a ripe orange. Acetaldehyde is being oxidized to acetic acid, methanol to formaldehyde, and the ascorbic acid is losing its vitamin C value.

A research chemist may prepare over a thousand new chemical compounds during a career. Thousands of new chemicals are either discovered in nature or prepared in the laboratory every year.

The basic chemical research done in ARS laboratories today is essential to help secure safe food and fiber needed in the tomorrows ahead.

Moderation in eating both nutritive and nonnutritive chemicals is the key to health. A dash of hot sauce will add zing, but don't overdo. Remember, it's the capsaicin—which makes all hot peppers hot—that adds that zesty taste.—*M.M.M.*

Mr. Ludwig inspects one of the hundreds of pots filled with soil from saltgrass pasture and planted with tall wheatgrass in greenhouse studies aimed at reclaiming over 1 million acres of potentially valuable saline Colorado and Wyoming pastureland (0974X1539–4).

Reclaiming Saltgrass Pastures

OVER 1 million acres of once valuable pastureland in Colorado and Wyoming may one day again produce high yields of desirable grasses. This land once supported high yields of valuable forage grasses—some even harvested for hay. Desirable species such as western wheatgrass (*Agropyron smithii*) and alkali sacaton (*Sporobolus airoides*) have been displaced by saltgrass (*Distichlis stricta*), an unpalatable grass for livestock.

Soils that make up this land, technically known as Natrustolls or Solonetz soils, have a high water table and are saline-alkaline. They contain three horizons or "layers" which soil scientists label A, B, and C horizons, A being the layer at the surface.

To get this land back into maximum production, ARS range scientist William J. McGinnies at the Crops Research Laboratory (Colorado State University, Fort Collins, CO 80523), recommends chemical eradication of the saltgrass and then plowing to a depth that just mixes the A and B horizons. Every effort should be made to avoid plowing into the saline C horizon and mixing it with the top two horizons, Dr. McGinnies advises.

Left: *Here is dramatic evidence of how highly saline, saltgrass-pasture soil—horizon "C"—restricts plant growth. Whiteness comes from salt carried to the surface through moisture evaporation (0974X1539–13).* **Below:** *Tall wheatgrass grows luxuriantly in soil obtained by mixing A and B horizons from saltgrass pasture and adding nitrogen fertilizer (0974X1539–8).*

Then desirable grasses such as tall wheatgrass (*Agropyron elongatum*), crested wheatgrass (*Agropyron desertorum*), Russian wildrye (*Elymus junceus*), and possibly smooth brome (*Bromus inermis*) can be seeded.

"Our greenhouse studies indicate that fertilizing at the field rate of 100 pounds of nitrogen per acre might produce the most economical forage yields. This amount of fertilizer on the A- and B-mix soil increases forage yields over 50 percent compared to the A and B mix without fertilization. Of course, we can get higher yields with applications of up to 400 pounds of nitrogen, but the cost of fertilizer makes these increased yields uneconomical," says Dr. McGinnies.

In his studies with Dr. McGinnies, Colorado State University graduate student Jim R. Ludwig discovered that each of these horizons, when separated and placed in 5-inch pots, produced decidedly different yields of tall wheatgrass. Extrapolating these greenhouse yields to actual field conditions would give 3,720 pounds of grass per acre from the A horizon, 1,895 pounds from the B horizon, and only 295 pounds from the C horizon.

A mixture of A and B horizons yielded an equivalent of 3,300 pounds per acre, while the mixture of all three horizons yielded less than half that—1,544 pounds.

Then why mix A and B horizons to get a lower yield rather than just plant in the A horizon? Because it is often impractical to plow only the A horizon; in many places this layer is only a few inches thick. In addition, the B horizon is usually impermeable to water. When unplowed soil is wetted, either by rain or irrigation, a seal forms between the A and B horizons. This seal causes excess water to pond on the soil surface and run off or evaporate, rather than soak into the soil.—*D. H. S.*

Protein-rich Oat Bran

OAT BRAN, a product that is high in fiber, can also be rich in protein if it is milled from groats (oats without hulls) of new high-protein oat varieties. Research now also shows that farmers' cultural practices may enhance nutritional qualities of the bran.

A strengthening of a trend is signaled in these findings by ARS chemist Vernon L. Youngs (Department of Agronomy, University of Wisconsin, Madison, WI 53706), and ARS physical science technician Keith D. Gilchrist. An increasing proportion of the Nation's oat crop is used in making foods for direct consumption by humans rather than in feeding livestock. Dr. Youngs is cooperating in studies with scientists of North Dakota State University, Fargo, on potential use of oat bran in baked goods.

In the studies completed at Madison, the researchers found that groats from Nora oats grown in University of Arkansas plots and fertilized with 30 pounds of nitrogen per acre had protein concentrations averaging 13 percent. Plots fertilized at a 90-pound rate produced groats averaging 15.4 percent protein. "We found that more of the heavily fertilized groats' extra protein was in the bran than in the germ or endosperm," said Dr. Youngs.

In another part of the research, analyses were made of seven oat varieties grown in two Wisconsin environments. Protein concentrations of groats from the two locations averaged 16.9 and 19.9 percent protein. As in the fertilizer study, the higher protein groats held more additional protein in the bran than in the other fractions. Bran from Goodland oats contained about 27 percent protein on a dry-weight basis.

"High-protein brans are produced as an indirect result of oat breeders' concentrated efforts to increase protein concentration in the oat groat," said Dr. Youngs. "The amino balance is quite good in oats, and it is fortunate that this good protein quality is being maintained in both the high-protein groats and the bran that can be milled from them."—*G. B. H.*

A Very Good Year

WINERIES with limited fermentation facilities could increase their yearly wine production by freezing crushed grapes after harvest and holding them until their fermentation facilities become available. Such a practice would avoid the rush to ferment all grapes at harvest, thus better utilizing facilities and labor.

This method of storing grapes would also provide the amateur winemaker with a supply of grapes throughout the year, not just during fall months. Often these winemakers must resort to grape juice concentrates to continue their activities after the fall grape harvest. Such wines differ from wines made from fresh grapes and lack premium quality.

ARS chemist Milford S. Brown (800 Buchanan St., Berkeley, CA 94710) says, "By using a method we have developed at the Western Regional Research Center we have even been able to extract more juice from grapes that have been frozen, compared to grapes that are crushed and then fermented."

Freezing breaks open cells of the grapes, releasing juice that would not come out in normal winemaking processes. It also releases more color from the skins of red grapes. This enhances the color of wine made from grapes that are color-deficient because of climatic conditions or genetic characteristics.

However, disruption of the cells by freezing also permits chemical reactions leading to undesirable odor, flavor, and color. These are prevented by adding 100 parts per million of sulfur dioxide to the crushed grapes before freezing. This antioxidant is normally added at the beginning of fermentation to inhibit the growth of undesirable micro-organisms.

The grapes are then frozen until fermentation facilities become available or until they are sold to amateur winemakers. After thawing, yeast is added and, as in current processes, the grapes are on their way to becoming wine. —*D. H. S.*

Off and On...

THE electric power supply for an irrigation system may be interrupted on some of the hottest summer days, with the operator's prior approval, on farms in a half-dozen Nebraska areas.

These farmers are cooperating in field tests of load management, a way to reduce demand on the power supplier during hours when irrigation, air conditioning, and other uses normally are the highest during the year.

For farmers, accepting occasional power interruptions may: (1) Hold down increases in electric rates, (2) be a condition for getting electric service to a new irrigation pump, or (3) obtain the services of a firm that helps plan irrigation so shutdowns will not reduce crop yields.

In the Custer Public Power District, Broken Bow, Nebr., power to cooperating irrigators was off parts of 28 days in 1973 but only 19 days in 1974 and 12 days in 1975 as personnel gained experience in load management.

ARS agricultural engineer LaVerne E. Stetson and University of Nebraska extension agricultural engineers John W. Addink and Darrell G. Watts are coordinating the tests, in cooperation with irrigators, six public power districts, and the Nebraska and National Rural Electric Associations.

The power districts see load management as a way to restrict the rise in charges by wholesalers that generate the power. Mr. Stetson explains that the cost of wholesale electric power is based on two charges. Besides billing for kilowatt-hours used, wholesalers levy a demand charge, or "ratchet," based on maximum use for 15, 30, or 60 minutes during the year. The demand charge recovers fixed costs for generation and transmission capacity not utilized during much of the year.

Shutting off 2,780 horsepower of irrigation load in the peak demand hour of 1975 reduced the demand charge about $74,000 for the Custer district, Mr. Stetson said, and may affect retail rates. Some power districts also offer lower rates to farmers who accept power interruptions on days of peak demand.

A second benefit, Mr. Stetson explains, is helping districts meet the demand for power to new irrigation installations without increasing capacity of powerlines and substations—extra capacity needed only during the irrigation season. With load management, the McCook Public Power District, McCook, Nebr., connected 1,300 kilowatts of new load in 1975 with an increase of only 320 kilowatts in seasonal peak demand.

The dry, hot summers of 1974 and 1975 stimulated an increase in new Nebraska irrigation wells from about 1,600 annually before 1970 to about 3,000, Nebraska extension irrigationist Paul E. Fischbach estimates. Electric power for new irrigation pumps has a cost advantage even though rates are rising, because they are not increasing as rapidly as the cost of other forms of energy.

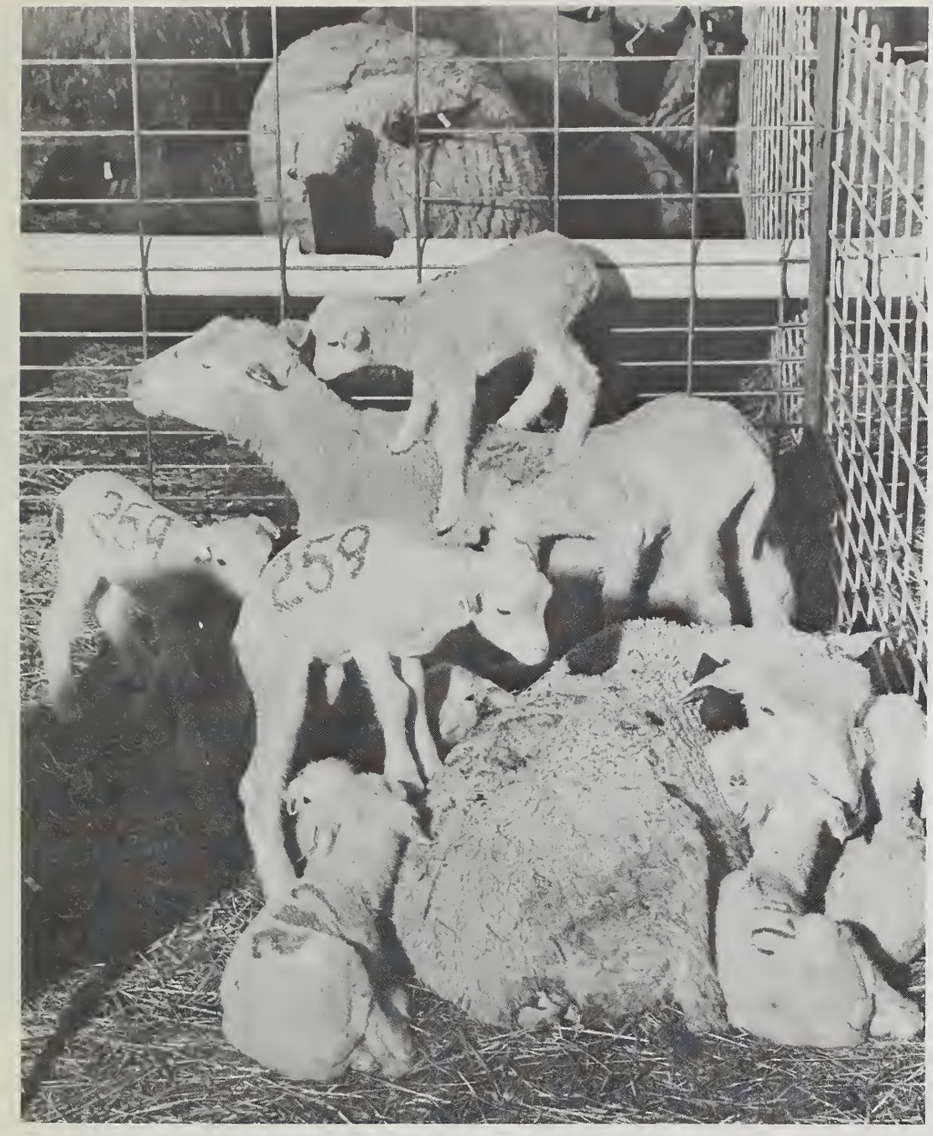
In the Custer district, irrigation interruptions were scheduled so 750 horsepower was off from 11 a.m. to 5 p.m. and 2,780 horsepower was off from 5 to 10 p.m. on high demand days. The McCook district had a similar schedule in 1974 but shifted to a schedule with one-sixth of the cooperating systems off each day, Monday through Saturday.

Center-pivot sprinklers operated by most cooperators can complete irrigation after a shutdown with little adverse effect, explains Mr. Stetson (5 Agricultural Engineering Building, University of Nebraska, Lincoln, NE 68583).

Mr. Stetson says the McCook district adopted the schedule calling for full days off because it serves many surface irrigation systems. A set number of hours is needed for water to reach the lower end of the field with surface irrigation. Interrupting power after irrigation starts results in overirrigating the upper part of the field before enough water reaches the lower end.

Power districts monitor substation loads daily, manually or by a telemetering system, during the irrigation season. Power to pumps of cooperators is shut off according to a schedule known to farmers whenever demand reaches a predetermined level. Most districts turn power off and on by a two-tone radio signal. In 1976 the Southwest Public Power District, Palisade, Nebr., used a ripple control system in which a signal is injected into the powerline to activate receivers on equipment to be turned off and on.

The Custer and McCook districts contracted with Agricultural Technology, Inc., McCook, Nebr., to provide irrigation scheduling for cooperating farmers.—*W. W. M.*



To reduce lamb mortality, ewes and their newborn lambs are isolated for 1 to 3 days before relocation to mixing pens like this one so that ewes claim their own lambs from a small group. If left in large pens at lambing, many ewes might not claim their lambs and death losses would be higher. Two lamb crops a year would increase the utilization of lambing facilities and lower the overhead costs per lamb produced (0676X 672–1).

Is Out-of-season Lambing Feasible?

PRODUCING two lamb crops a year is possible in experiments, but is it a feasible management practice for the commercial sheepman?

Should an affirmative answer to this question come from comprehensive studies underway at the U.S. Meat Animal Research Center, Clay Center, Nebr., operating economies of intensive production could be realized by lamb producers.

Induced fertile matings in spring or summer to supplement fall matings would make full use of the ewe's reproductive capability, since the gestation period is about 5 months. Two lamb crops a year would even out marketings through the year, equalize lambing labor requirements, increase utilization of lambing facilities, and lower the sheepman's overhead costs per lamb produced.

A team of animal physiologists has studies underway to identify causes of conception failure, in both ewes and rams, in out-of-season matings and possibly find ways of reducing the losses. The team includes Sherrill E. Echternkamp, John J. Ford, Donald D. Lunstra, and Bruce D. Schanbacher of ARS (P.O. Box 166, Clay Center, NE 68933), and Ronald K. Christenson of the cooperating University of Nebraska, Lincoln.

Physiologists in 1945 first showed that injections of an ovulating hormone could bring ewes into heat, and 5 to 10 percent conceived. ARS scientists in Idaho later achieved a 29-percent lambing rate in 130 ewes with an improved hormone treatment (AGR. RES., July 1968, p. 10).

At USMARC, hormone treatments induced heat (behavioral estrus) in 96 percent of 165 crossbred ewes in a 34-

Out-of-season Lambing

Soon after birth, lambs are weighed, ear-tagged, and vaccinated by agricultural research technicians Harry Chernak, left, and Carrol Reatzel. Labor force requirements could be equalized with a second annual lamb crop (0676X672–14).

day spring breeding period. Sixty-three percent of them lambed, duplicating results of an earlier experiment. A total of 193 lambs were produced by 104 treated ewes, in comparison with 7 lambs by 5 of 91 untreated control ewes.

The researchers used a three-step hormone treatment. First, they inserted intravaginal progestogen pessaries, which remained in place 7 or 15 days. Then they injected progesterone the day the pessaries were removed. The next day and 15 days later they injected pregnant mare serum, gonodotropin.

In additional studies, the scientists are seeking the reasons for failure to lamb by ewes in which heat was induced. Multiple causes involving both ewe and ram are probable.

One study, for example, shows that ovulation rate is lower in May than November, and still lower in June than in May. The rate was higher at all three times in the Finnsheep than in the Hampshires, indicating a variation by breed.

Fertilization failure rather than embryonic mortality has been identified as the major contributor to lower fertility in Finnsheep-cross ewes treated for mating out of season. About 60 percent of the ova were fertilized when collected about 48 hours after mating, in contrast with 87 percent of ova from nontreated ewes mated in fall. The researchers noted that a relatively high percentage of the ova contained fragmented cells or showed other abnormalities of cell division.

The number of sperm attached to fertilized ova averaged 3.8 in induced matings and 79.1 in fall matings. Nonfertilized ova had no sperm attached and no sperm were found when oviducts were flushed, suggesting disturbance in sperm transport or reduction in number of sperm deposited in ewes mated out of season.

In concurrent studies on reproductive performance of rams, the researchers devised a system for measuring their mating activity and also collected blood samples at 8-week intervals for a year to measure fluctuations in hormone levels.

Mating activity of five Finnsheep and five Suffolk rams was highest at the October peak breeding season, declined by 50 percent by late spring, then again increased to the full peak. Levels of serum testosterone, a male hormone, were similarly highest in October, then declined to lowest levels in March before rising to previous fall's levels. A cause and effect relationship between testosterone level and mating activity has not been demonstrated.

Levels of luteinizing hormone in serum tended to decrease during winter

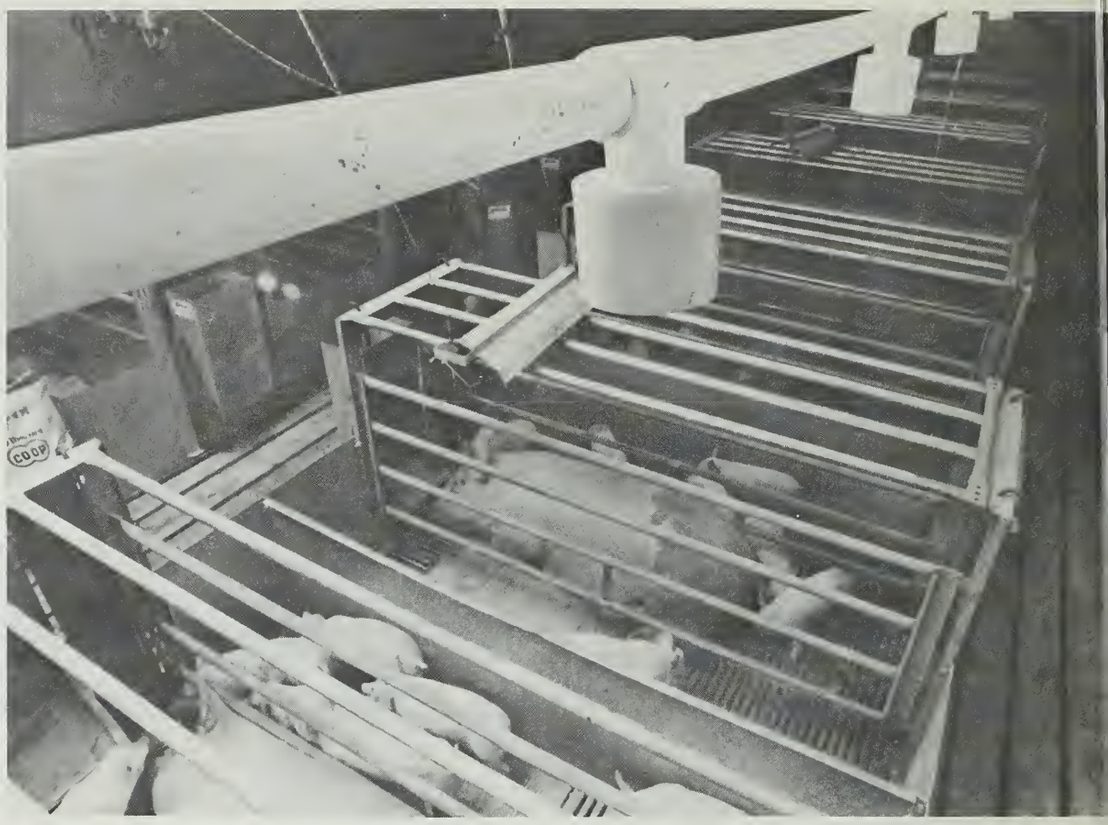
Orphan lambs—those unclaimed by ewes, or those the ewes are not able to care for—are taught to take formula from a "MARC nurser" by agricultural research technician Lyle Karnatz. The nurser, developed by scientists at the U.S. Meat Animal Research Center, has gained wide commercial acceptance (0676X681–33A).

and spring until May, then rise sharply but fluctuate. The scientists suggest day length may be the major factor controlling its release. This pituitary hormone has a vital role in releasing the ova during conception.

An additional study also indicated seasonal differences in secretion of luteinizing hormone and testosterone and demonstrated cause and effect relationship between the two hormones. The scientists found no consistent relationship between these hormones and estradiol, an estrogen, nor seasonal differences in estradiol levels.

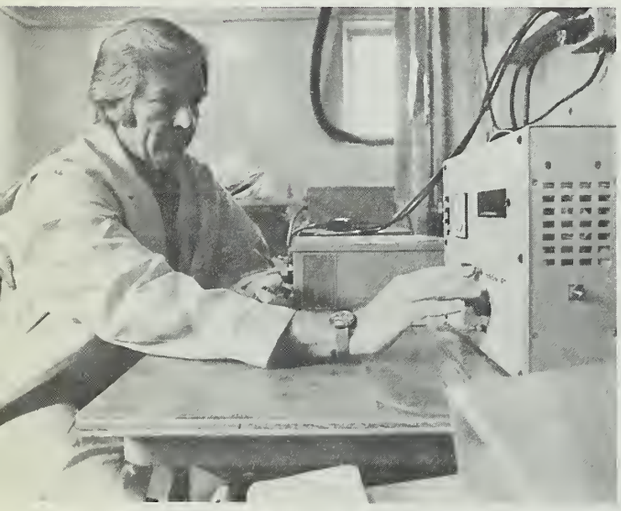
USMARC scientists will continue research on causes of lower conception rates in induced matings. They also are exploring the possibility of natural selection for out-of-season mating success, and they are determining the optimum nutritional requirements. *—W. W. M.*

Suffolk sheep used in experiments on out-of-season reproductive performance are worked by agricultural research technician Robert Anderson, left, and sheep manager Thomas Lewis (0676X674–13).



A row of charging points located above the farrowing crates in a typical swine production unit. The points are located to optimize the distribution of electrons throughout the building (0876X1036–29).

Ionized Air Reduces Bacteria



Mr. Songer monitors the particulate matter in the ionization chamber while simultaneously collecting airborne virus particles for assay. By comparing the total particulate matter with the viable particulate matter, one can determine the physical, biological, and total viral aerosol decay (0876X1035–22).

ATTRACTION of particles carrying opposite electrical charges is the basis of a technique for restricting the spread of airborne swine diseases in confinement buildings.

ARS microbiologist Joseph R. Songer explains that negatively charged ions discharged into the air collide with airborne micro-organisms and dust particles. These organisms and particles pick up a negative charge, then migrate to positively charged plates or wall surfaces.

Tests at the National Animal Disease Center (P.O. Box 70, Ames, IA 50010), indicate that ionized air can reduce but not completely control airborne bacteria, especially in highly contaminated swine barns. Bacterial counts before ionization varied from 1,000 to 5,000 per cubic foot of air, influenced by animal activity and air circulation patterns that caused minute particles of fecal material to become airborne.

In a typical test, bacterial count per cubic foot dropped from 4,670 to 357, measured an hour after ionization.

Researchers in the early 1960's had observed that bacteria and mold growth were suppressed in ionized air, and that negative ion atmospheres had more effect than positive ion atmospheres. More recently, agricultural engineer Dwaine S. Bundy of Iowa State University, Ames, evaluated a corona discharge ionization system marketed for dust control in swine buildings. He concluded that it was most useful in dusty conditions with minimum ventilation but no more effective than adequate ventilation for dust control.

Mr. Songer, microbiologist Donald T. Braymen, and technician Raymond G. Mathis then joined Dr. Bundy in evaluating corona discharge ionization for disease control.

The researchers supplemented initial tests in swine barns with experiments

simulating normal isolation conditions with a low concentration of airborne organisms. These tests were run in a special chamber with ungrounded aluminum foil covering the walls and wired to a high-voltage, positive polarity power supply. The ceilings were negatively charged, and air was ionized from negatively charged needlepoints suspended below the ceiling. A centrally located atomizer dispersed test organisms, and samples were collected in animal cages.

In tests with *Serattia marcescens*, the average number of particles per cubic foot was 831 without ionization and 129 with ionization, for an average reduction of 84 percent and a range of 67 to 98 percent in individual tests. In two series of tests with *Escherichia coli* bacteriophage as the test organism, the average reduction was 89 and 81 percent, from concentrations of 3,750 and 1,754 particles per cubic foot.

The significance of the reduction, Mr. Songer says, depends on the infective dose of the organism and the organism's susceptibility to other environmental conditions, the concentration of charged particles maintained, and the natural resistance and defense mechanisms of exposed animals.—*W. W. M.*

The high-voltage discharge needlepoints are the sites of electron production. The electrons ionize oxygen molecules in the air which in turn attach themselves to aerosol particulates, giving them a charge of the same polarity. The cup protects the needle (0876X1036–14).

White Rot of Onions

RELIEF may be on the way for onions attacked by white rot. White rot is a plant disease caused by *Sclerotium cepivorum*, a soilborne fungus. In warm weather the sclerotia, or resting structures, are dormant. In the fall, however, shortly after winter onions are planted, cooler temperatures activate threadlike webs called mycelia which infect the roots and bulbs.

The onion's growth appears normal during the winter. Just before the spring harvest, however, an infected plant begins to wilt. If it is pulled out of the ground, the onion breaks away easily from its roots, revealing the diseased bulb.

Botran, the only chemical registered for use to control white rot of onion, is not effective at its approved rate. Pesticide manufacturers are reluctant to develop and test other chemical treatments because onions as well as garlic, leeks, chives, and shallots (other members of the onion family susceptible to white rot) are planted on limited acreages.

Tests on bunching onions have shown three chemicals to be highly effective in controlling white rot, says plant pathologist Peter B. Adams (Soilborne Diseases Laboratory, Beltsville Agricultural Research Center, Beltsville, MD 20705).

Potassium azide, a fumigant fungicide applied in granular form to the soil 2 weeks before planting at a rate of 25 pounds of active ingredient per acre, reduced infectivity from 95 to 13 percent and resulted in a yield of 32,130 pounds per acre compared with 1,514 in the control field.

Benomyl and thiophanate methyl, both systemic fungicides applied as in-furrow sprays during planting at a rate of about 10 pounds of active ingredient per acre, reduced infection to 1 percent or less and resulted in yields of more than 32,000 pounds per acre.

These two fungicides and potassium azide were introduced to the field after extensive greenhouse tests by Dr. Adams and Dr. George C. Papavizas, Chief of the Soilborne Diseases Laboratory, had shown that, of several scores of fungicides, these were the most effective in controlling white rot when used in small amounts.

Since none of these chemicals is registered for use on onions, Dr. Adams is conducting residue tests required for Environmental Protection Agency labeling, in addition to continued tests for effectiveness.

Exact loss estimates are not available, but Dr. Adams says that more than 10,000 acres of onion fields in California, Oregon, Washington, and New Jersey are severely infected. White rot increases in intensity from year to year until a farmer must quit growing winter onions in the infested area. Even when a field has been abandoned for 10 years or more, the disease may persist in the soil at a high rate of infectivity.

Working with Dr. Adams in this research are Dr. Otis C. Maloy of Washington State University, Pullman, Wash., and Dr. John K. Springer of the Rutgers Research and Development Center, Bridgeton, N.J.—*J.P.O.*

"Tracking the sugars." Each of the many sugars in a polysaccharide leaves its identifying "tracks" when flushed out with paper chromatography. Dr. Sandford, left, and chemist Clarence A. Knutson, Jr., track down and identify a covey of sugar components they have flushed out of three polysaccharides produced by microscopic cells from the ARS Culture Collection at the Northern Regional Research Center (1075R2144–35A).

Push for Petroleum

THE United States enters its third century with a push from microscopic cells to help meet the crisis of diminishing petroleum reserves.

Bacterial cells, launched into a new fermentation industry from the ARS Culture Collection, provide the push for a new harvest in domestic oilfields. Some fields, although twice harvested, tenaciously retain as much crude oil as they have given up since the first well started pumping in 1859.

The cells grow on glucose sugar, the building unit of starch from corn and other crops. They make a gummy substance that thickens water.

Called xanthan gum, it is unusual among thickening agents because it reduces the fluidity of water even in the presence of salt and heat. In the new harvest, thickened water is pumped into the earth to push tenaciously held crude oil to pumping wells.

Produced by Kelco Co. of San Diego, Calif., since the early 1960's xanthan is used in food and industrial products ranging from salad dressings to petroleum recovery fluids.

To cut costs in the new petroleum harvest, industrial leaders are considering oilfield production of xanthan and use of the liquid, fermentation broth. Pfizer, Inc., New York, N.Y., has started supplying undried broth on a trial basis to the petroleum industry for field testing.

"Oilfield production and use of the broth can drastically cut the cost of xanthan in petroleum recovery" says the director of research at Midwest Solvents, a fermentation company in Atchison, Kans. Gerald Lasater, experienced in oilfield production of xanthan, points out, "Using the liquid broth eliminates the high cost of drying—evaporating all that water. Onsite production drastically cuts costs of hauling the water."

The new petroleum harvest is one xanthan use summarized by Paul A. Sandford, chemist at the Northern Regional Research Center (1815 North University St., Peoria, IL 61604), at the American Chemical Society (ACS) centennial, 1976 fall meeting. The meeting came just 17 years after the ARS Center released xanthan as gum B–1459 for industrial development and 117 years after the first oil well began pumping near Titusville, Pa.

Now xanthan is being tried near Titusville in the new petroleum harvest. The Penn Grade Crude Oil Association, Bradford, Pa., and Cities Service, Tulsa, Okla., are studying xanthan in U.S. Energy Research and Development Administration (ERDA) projects.

In the new harvest, water thickened with xanthan gum or a chemical is pumped into the earth after a detergent mixture. The thickened water, less fluid than either crude oil or detergent mixture, pushes them in a broad sweep

through the rock reservoir. The xanthan solution is designed not to stream through paths of least resistance, which would bypass pockets of oil, and not to plug the porous rock.

This clean sweep by detergent pushed by thickened water is called "micellar-polymer flooding." The detergent mixture is a "micellar dispersion," and xanthan or other water-thickening agent is the polymer. Marathon Oil Co. holds patents on the technology.

Micellar-polymer flooding was conceived as one of several tertiary recovery methods—ways to harvest oil held tenaciously after primary drilling-pumping and secondary water flooding. Of 440 billion barrels of oil discovered in the United States, only 106 billion have been harvested since 1859. Now micellar-polymer flooding may be tried as "exotic" or "enhanced" recovery of even the first crop of oil.

Esso Production Research Co. (Exxon) patented the use of xanthan in a drilling fluid in 1965, and in an improved secondary process, which they now consider enhanced recovery, in 1967. Shell Oil soon will try the gum in a comparison of water flooding and polymer flooding now underway near Fresno, Calif., another ERDA project.

"Xanthan gum exhibits many desirable properties for enhanced recovery when compared with other available polymers," Erik I. Sandvik of Exxon said at the ACS meeting. "Enhanced oil recovery processes are expected to provide a significant addition to U.S. recoverable petroleum reserves."

Recoverable reserves, the oil that can be harvested conventionally, are estimated at 34 billion barrels. An additional 7 to 9 billion barrels, depending on costs and oil prices, could be harvested by micellar-polymer flooding, a consulting firm reported to the Federal Energy Administration in April.

Increased domestic reserves would give the United States a hedge against inflationary foreign oil prices and time to develop other energy sources. "The volume of imports is already so high," Ted M. Geffen of Amoco warned in 1975, "that it presents frightening prospects for our national security, standard of living, and geopolitical position."

The use of xanthan in this emergency was made possible by ARS studies that began more than 30 years ago, Dr. Sandford points out. Research in 1944 on dextran as a research tool, which was to become a blood-volume expander, led chemist Allene R. Jeanes, now retired, to propose a search for new industrial products among polysaccharides made by microscopic cells growing on glucose. A polysaccharide is made up of "many sugar" units or building blocks. Glucose is the sugar unit of both dextran and starch, a polysaccharide produced by corn and other crops.

In 1956, Dr. Jeanes discovered unusual water-thickening properties in a substance produced by cells from culture No. B–1459 of the ARS collection. Martin C. Cadmus, microbiologist, developed fermentation conditions for

Microbiological technician Clarence D. Crowell seals ampules of microscopic cells under vacuum for preservation in the ARS Culture Collection and shipping in response to requests from scientists in industry and research (1075R2146–26).

Chemical engineer Robert W. Silman adjusts airflow into the fermentor in a pilot plant study of the batch process for making xanthan gum. Mr. Rogovin copies pH readings. In the process, cells of Xanthomonas campestris, *a bacterium, grow in a glucose solution in the fermentor. Glucose, a simple sugar, is a component of starch from cereal grains such as corn and wheat and from other crops (1075R2144–8A).*

Push for Petroleum

Xanthan gum—a water-thickening substance produced by bacterial cells that grow on glucose sugar—helps harvest oil from old wells. The ability of xanthan gum to thicken water is demonstrated by Dr. Sandford. The 1-percent solution of xanthan, left, had held sand grains in suspension for 3 days when the photo was taken. Water, right, allowed the sand to settle immediately (1075R2145–19).

growing the cells (a bacterium, *Xanthomonas campestris*) in a liquid medium containing glucose. He worked with chemical engineer S. Peter Rogovin, now retired, in scaling up the fermentation from laboratory to pilot plant.

Dr. Jeanes credits Mr. Rogovin with providing "the detailed basis for all the industrial production that has ensued." In introducing B–1459 to the petroleum industry, Mr. Rogovin suggested producing the gum in the oilfield and using the broth to thicken water.

The ARS team reported the gum in *Information on Polysaccharide B–1459*, in September 1959—100 years after Edwin L. Drake brought in the first oil well near Titusville.

"The gum research ripened in industry in time for a part in a bicentennial assertion of energy independence," say Dwight L. Miller, Northern Center assistant director. "The xanthan industry is expanding when the petroleum industry is looking for new recovery methods."

The Center now is studying ways to produce a series of xanthan gums, each with standardized thickening properties. Dr. Sandford says solutions of some of the improved xanthans are three times as viscous as solutions of some commercial xanthans.—*D. H. M.*

Mention of company is for identification only and does not imply endorsement by the U.S. Department of Agriculture.

THE PETROLEUM DEFICIT is this Nation's third critical need in less than 40 years tackled by U.S. industry with microscopic cells from the same ARS Culture Collection that launched xanthan gum, says Clifford W. Hesseltine, chief of fermentation research at the Northern Center.

In the early 1940's, a mold from the collection doubled penicillin yields from "surface" production, where the cells grow as a mat on the surface of the liquid nutrient. Soon after, another mold from the collection assured production by the "submerged" process, where the cells grow throughout the liquid in tanks, or fermentors. This submerged process provided penicillin in time to save lives in World War II and launched the antibiotics industry.

In the 1950's, industry used bacterial cells from the ARS collection to produce dextran as a blood-volume expander. Dextran was available in time to save lives during the Korean war. Dextran and xanthan were the first industrial polysaccharides produced by microscopic cells.

AGRISEARCH NOTES

Cleaner hands with orange oil

WHAT'S the newest "cosmetic" used in heavy machine repair shops? A byproduct from oranges that not only pleasantly degreases the hands of mechanics but also removes the sludge from the engines.

According to Lester Lehning, mechanic-in-charge at an industrial machine repair shop, Bartow Air Base, Fla., d-limonene hand cleaners were as effective as commercial waterless hand cleaners. And as engine cleaners, d-limonene-containing gel and liquid both smelled better and caused less skin irritation.

Increasing recovery of distilled oils by the citrus industry prompted citrus researchers to find potential uses for these solvents. The principal component in orange oil is d-limonene.

Scientists at the ARS Citrus and Subtropical Products Laboratory (P.O. Box 1909, Winter Haven, FL 33880), used distilled citrus oil, which is about 94 percent d-limonene, obtained from a local supplier. For the gel formula, they added 510 grams (g) of the distilled oil to stearic acid, oleic acid (an emulsifying agent), sodium hydroxide, and water.

For a lotion-type hand cleaner, lanolin, four emulsifiers, and water were mixed with 300 to 450 g of d-limonene.

For the gel-type engine cleaner, 500 g of d-limonene were mixed with emulsifier, water, and triethanolamine.

"The gel and lotion hand cleaners incorporating d-limonene as the main solvent were prepared and evaluated as waterless hand cleaners. Lehning conducted tests with his mechanics, and the results with the distilled oils were equal and, overall, better," said chemist Richard L. Coleman.

In other tests, the mechanics found the citrus oil products as effective as commercial cleaners in removing grease, sludges, lacquerlike residues, and other deposits that accumulate on and in machinery. They expressed a definite preference for the citrus oil engine cleaner, primarily because it caused less skin irritation and had a more agreeable odor.

The orange oil formulas, based on a largely unused byproduct, are now drawing the interest of industry.—*P. L. G.*

Moving bees reduces honey

COLONIES of honey bees that are moved in late fall may need more sugar as supplemental food for wintering than colonies left undisturbed.

Moving causes colonies to break their tight cluster, become excited, and lose heat, says ARS entomologist Floyd E. Moeller (Department of Entomology, University of Wisconsin, Madison, WI 53706), who conducted experiments in cooperation with the Wisconsin Agricultural Experiment Station. Colonies that he moved once in late November consumed 30.4 kilograms (kg) of honey in winter and early spring compared with 25 kg consumed by undisturbed colonies. Colonies that he moved twice consumed 34 kg.

Dr. Moeller also measured effects of moving colonies 13 to 21 miles in early July. The bees lost foraging time during the first week after moving while they oriented to clover fields similar to fields from which they had moved. Their disorientation was reflected by a smaller weight gain of the colonies compared with gains of other colonies that were already accustomed to foraging in the same fields.

Colonies that Dr. Moeller moved twice in the same evening—to new locations and back—stored as much honey as colonies that he did not move. Moving bees on two successive evenings to new foraging areas caused colonies to store less honey than colonies that were moved to only one new foraging area.

Beekeepers move colonies to obtain maximum pollination of a crop or to increase honey production. Before moves are made to increase honey production, says Dr. Moeller, beekeepers should consider whether the bees' loss of foraging time will be more than offset by forage quality of the new bee pasture.—*G. B. H.*

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AGRISEARCH NOTES

Rating the bad guys

A VETERINARIAN recently developed a rat bioassay that successfully estimates the toxicity of an extract from three larkspur species.

Each year many cattle die from larkspur poisoning in the Western United States. Being able to estimate the toxicity of larkspur will allow the risk of death loss when livestock are grazed in certain areas or at a particular time of the year to be estimated, and thereby improve rangeland use.

Differences in toxicity between larkspur species have been suspected, but until now no standard method of comparison has been available. ARS veterinarian John D. Olsen, Poisonous Plant Research Laboratory (1150 East 14th North, Logan, UT 84322), thinks he has found such a method.

He collects above-ground parts of larkspur plants before flowering occurs. Plant material is air-dried, ground, and extracted. This extract is later reconstituted in a saline solution which is subcutaneously injected into laboratory rats. The rats are observed for 24 hours for toxicity effects.

Dr. Olsen used his method to estimate and compare the toxicity of *Delphinium barbeyi*, *D. glaucescens*, and *D. occidentale*. He found *D. barbeyi* to be the most toxic and *D. occidentale*, the least toxic of the three species.

The bioassay method of Dr. Olsen is still in the testing stage. He plans to use it next to estimate the differences in toxicity of larkspur species during various stages of plant growth and within a single growing season, and to determine the effects of environmental factors.—*L. C. Y.*

Good bread, too

EXTENDED-EXTRACTION FLOUR has enhanced nutritive value and makes good bread, too.

ARS food technologist William C. Shuey and associates earlier showed that at least 5 percent more flour can be milled from each bushel of wheat by extended extraction, regrinding the millfeed products and adding the flour to the usual straight-grade flour (AGR. RES., Mar. 1976, p. 10).

Now chemist Clifford A. Watson, Dr. Shuey, and technician Robert D. Crawford (106 Harris Hall, North Dakota State University, Fargo, ND 58102), have compared breads made with extended-extraction and straight-grade flours.

"In general, doughs of both flours handled similarly and made equally good bread," Dr. Watson reports. "The consumer probably would not detect the difference in breads made from the two types of flour unless the loaves were placed side by side."

The researchers compared flours made from five spring wheat varieties—semidwarf Prodax, Kitt, and Era and conventional height Cris and Waldron—in cooperation with North Dakota State University, Fargo.

As in earlier tests, more vitamin B_1, the essential amino acid lysine, and minerals were recovered from the wheat by extended extraction. Average increases were 12.2 percent for vitamin B_1 and 9.1 percent for lysine. Greater recovery of vitamin B_1 was not related to wheat type, but lysine increases were 17 percent in flours from semidwarfs and 5 percent from conventional height varieties.—*W. W. M.*

When reporting research involving pesticides, this magazine does not imply that pesticide uses discussed have been registered. Registration is necessary before recommendation. Pesticides can be injurious to humans, domestic animals, desirable plants, and fish or other wildlife—if not handled or applied properly. Use all pesticides selectively and carefully.

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